Space Weather Technical Forecast

Issued on Monday, 24 January 2022 at 00:45 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Slight Chance of G1 through first half of UTC week. Continuation of Active electron fluence becoming less likely with time.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low in the past 24 hours, with no significant X-ray flares recorded. AR2933 disappeared from view over the southwestern limb in the 24 hours to leave one magnetically simple and stable resident group: AR2934 which was analysed as Hsx/Alpha.

No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, eased from slightly elevated levels narrowly in excess of 400km/s to approach 300km/s by the period's end. The solar wind density was stable within single figures ppcc throughout. The IMF was slightly erratic in character but small in magnitude, with a peak of 6nT, although the north-south component was mostly anti-aligned with Earth's field, with a range of -5 to +4nT, the latter only being achieved near the end of the 24 hours. The phi angle was also noisy, but spent much of the UTC day in negative territory, towards the sun.

The net effect of the above solar measures was provisionally mostly Quiet Kp indices, but peaking at 3+ in the 03-06UTC interval while Bz was negative and the solar wind speed was near its highest.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV), was at High levels, with a peak value of 6130pfu at 23/1620UTC. Electron fluence persisted above the 1e8 Active threshold throughout, with a slight rising trend, with fluence at 23/2400UTC measured at 2.38e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Very Low, with one sunspot on the Earth-facing side of the disc, perhaps offering just a 5% chance of C-class flares per day.

Solar Wind / Geomagnetic Activity: There are several glancing incidence CMEs possible in the forecast period, with forecast arrivals up to and including the middle of the UTC week. Please see the Geomagnetic Storms section for full details of these CMEs. In addition, coronal holes 45 and 46 are likely to feature, starting from day one and perhaps reinforced midweek, with the risk period roughly coincident with the CME arrival threat.

It goes without saying that the resultant forecast is very low confidence in timing and phasing of G1 risk through the start of the UTC week, but confidence is nonetheless higher for this being

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

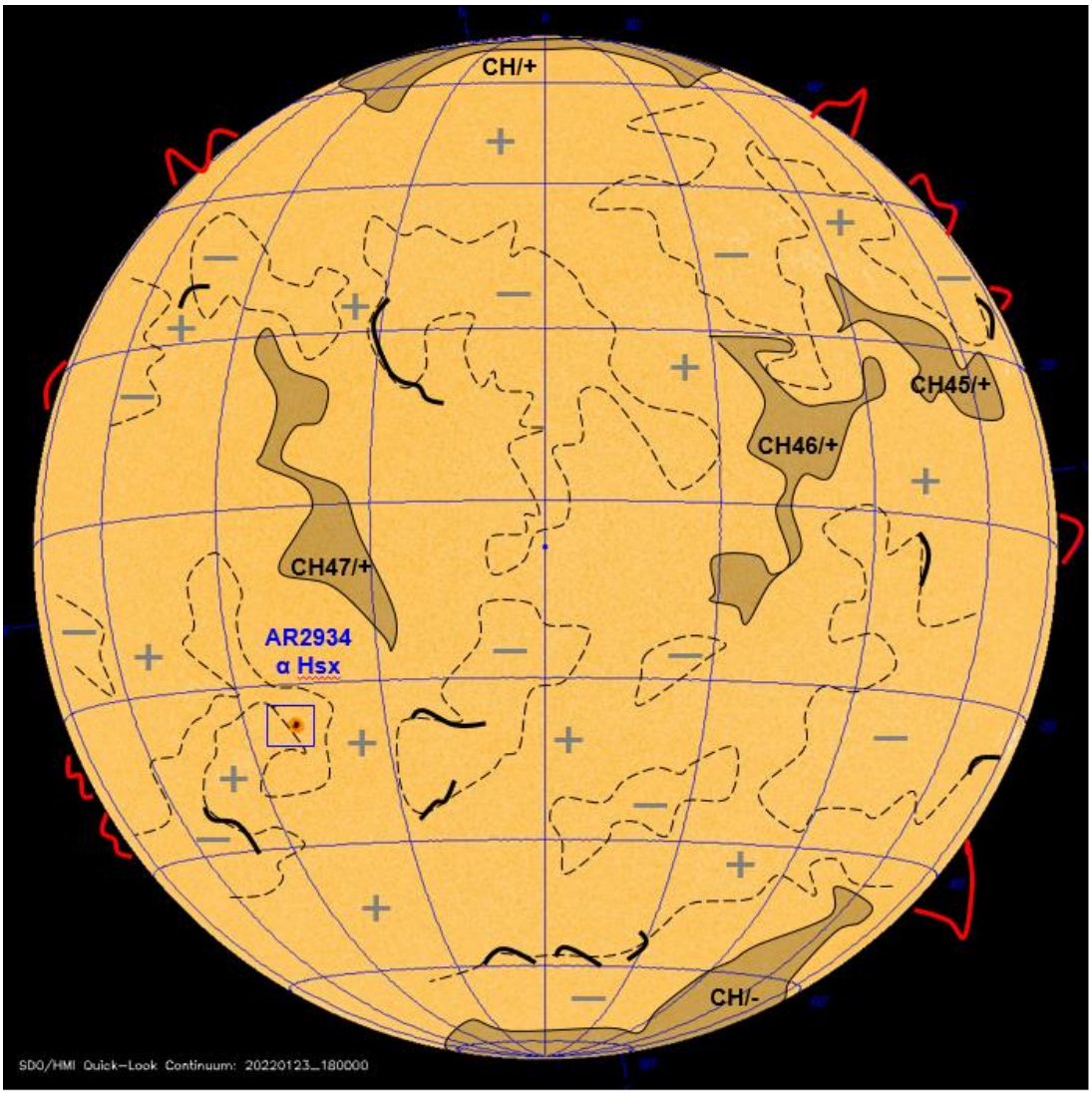
the maximum in attained geomagnetic activity.

In the absence of any CMEs, Quiet to Unsettled activity should very soon give way to more frequent Unsettled periods, with a chance of isolated Active intervals associated with coronal hole influences, waning after midweek.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels.

The high energy electron flux (greater than 2MeV) is expected to continue to reach High flux levels at the diurnal peak at first. However, the forecast carries low confidence, with the potential for interruptions from CME glances. The 24-hour fluence is forecast to persist above the Active threshold initially, but with an increasing chance of dropping below this level given the weight of 'resetting opportunities' from coronal holes and the numerous possible CMEs.

Figure 1. Solar Analysis Valid 23/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

There are several glancing incidence CMEs possible in the forecast period, with forecast arrivals up to and including the middle of the UTC week.

Firstly, a CME from 19 January should reach 1AU by the very start of the four-day period, although this feature is now overdue which may mitigate against G1 being realised. A second CME, associated with a southwest quadrant filament eruption (possibly triggered by the M5 flare from Ex-AR2929 on 20 January), is modelled as potentially brushing Earth on day one, Monday 24 January. Thirdly, a further filament eruption and subsequent CME from near the southeastern limb on 21 January, could also possibly brush past Earth on day one, albeit with lower confidence in arrival. Fourthly and finally, a filament lift off on 22 January shows a possible glance late on day two, Tuesday 25 or early 26 January. This final CME candidate shows a long tail in its arrival estimate, potentially arriving as late as 27 January, but with suitably attenuated effects. This means that there is a daily Slight Chance of G1 through to midweek UTC.

The ambient solar wind is not without a contribution in the period. The western solar hemisphere doublet of coronal holes 45 and 46 is likely to feature from day one, with the risk period roughly coincident with the CME arrival threat according to STEREO A PLASTIC data, which suggest an initial 450km/s high speed stream perhaps increasing midweek, although the STEREO data are noisy and at the very limit of their forecast range by this time, with some points in excess of 500km/s. The contribution of these coronal holes is somewhat masked by the risk of CMEs, although the currently observed late increase at STEREO does serve to slightly extend the G1 risk.

It goes without saying that the resultant forecast is very low confidence in timing and phasing of G1 risk through the start of the UTC week, but confidence is nonetheless higher for this being the maximum in attained geomagnetic activity. In the absence of any CMEs, Quiet to Unsettled activity should very soon give way to more frequent Unsettled periods, with a chance of isolated Active intervals associated with coronal hole influences, waning after midweek.

Geo-Magnetic Storm	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Minor or Moderate	**G1 to G2**	No	20	20	20	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

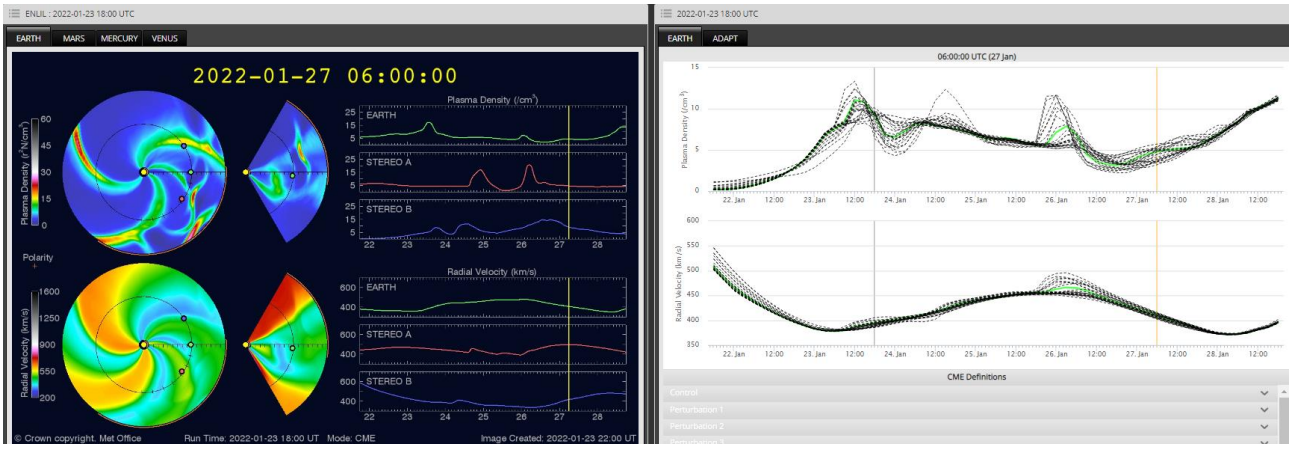
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
19/1837	Partial	Filament	S16 W017	288	23/1500UTC, now overdue	Possibly missed
20/1642	Partial	Filament	S02 W059	478	24/1200UTC	Most likely ahead of Earth
21/0900	Partial	Filament	S23 E061	601	24/1200UTC	Possible glance
22/0630	Partial	Filament	N15 E020	400	26/0001UTC	Possible glance

Figure 2: MOSWOC Enlil and ensemble, showing numerous glancing incidence CMEs possible in the coming three days. Note that there is little disturbance in the control ensemble member throughout, especially in terms of solar wind speed (green line on right graph). The large spread in amplitude of the different solutions serves to highlight the low confidence in all the CMEs that feature in the forecast. The underlying rising trend is due to CH45 and CH46, and is accepted in terms of both timing and magnitude.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

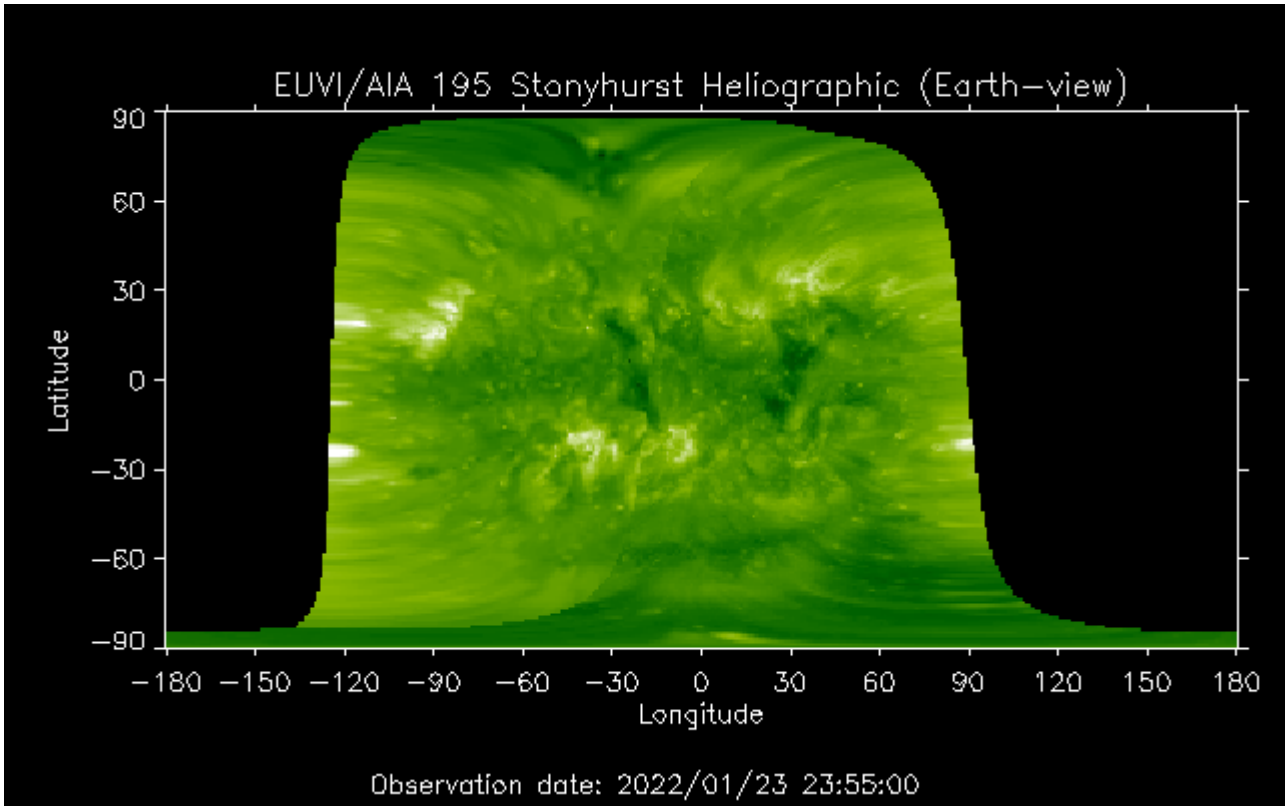
Radio Blackouts - X-Ray Flares:

There is now just one sunspot on the Earth-facing side of the disc, the magnetically simple and stable AR2934. This offers very little in terms of significant X-ray flare risk in its current guise, perhaps 5% chance of C-class flares per day.

The number of sunspot groups on the disc may increase through the coming UTC working week, as although there are no returning regions due, there are a few small bright flux regions hinted at in STEREO A EUVI 195 imagery. Any contribution to flare risk will be assessed once they present on the Earth-facing side, meaning a flat 1% daily risk of M-class flares is proposed throughout the period for now.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Cylindrical projection of the whole sun in EUV, showing a realitvely featureless disc and eastern horizon, with any newly-developed arriving regions appearing to be small.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

No solar radiation storms are expected in the period given the paucity of sunspots and inactivity on the facing side of the sun.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as measured by GOES-16 at GEO, has remained on a steady oscillation within High levels over the past 24 hours. This has relied on the absence of both transient and coronal hole activity over the UTC weekend. Clearly this state of affairs is unlikely to continue, with CH45 due imminently by STEREO A PLASTIC data (perhaps reaching 450km/s) and then 46 in turn.

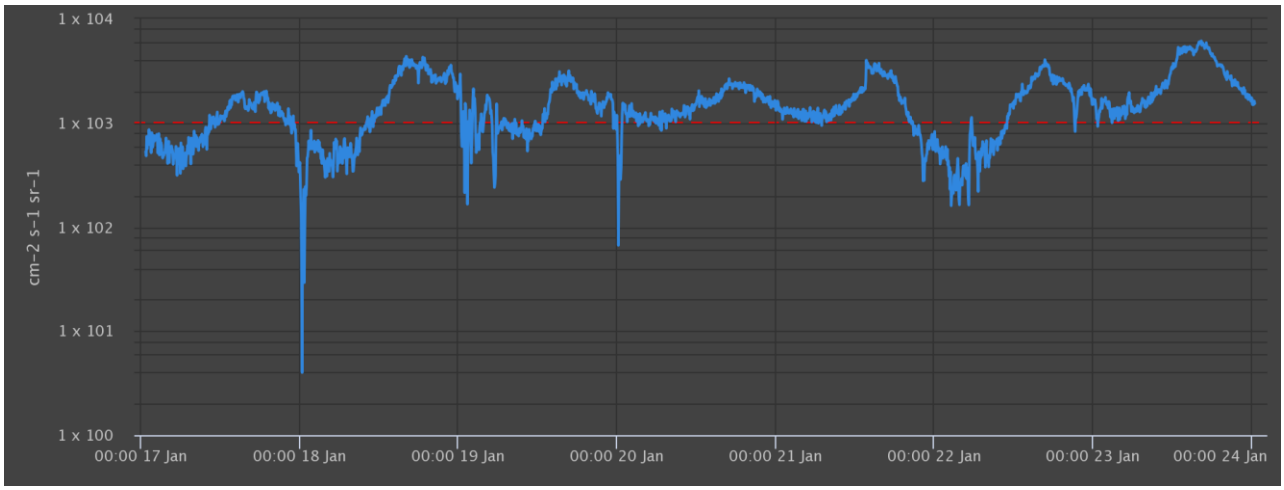
In addition to this more assured reset from coronal hole activity, the sheer number of candidates for glancing incidence CMEs in the period should mean that continuation of Active electron fluence becomes relatively less likely with time. To this end, the falling trend suggested by REFM is tentatively accepted, even if the number of CMEs in the forecast mean that the detail of the decline from current levels is of lower confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: The past week in high energy electrons at GOES 16 – in the wake of CH44 and its late resurgence to 600km/s. This state of affairs is unlikely to be maintained beyond midweek, with the twin assaults of coronal hole activity and up to four transients –increasingly likely to reset counts at more modest levels.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.